

CONDUCTING A REPRODUCIBLE SYSTEMATIC REVIEW: PRACTICAL INSIGHTS

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A systematic review is a research methodology that involves answering a pre-defined research question using data extracted from primary studies, preferably those answering the same research question or at least providing data that can be used to answer the research question^[1]. Systematic reviews rely on a positivist research paradigm, which means the steps undertaken by the researcher, if repeated by another, can yield the same findings and conclusions. Unfortunately, many published systematic reviews are not reproducible because they are poorly reported, which undermines their credibility, trustworthiness, and reliability^[2]. In this article, I will give guidance on conducting a reproducible systematic review as a strategy to enhance the reliability of its findings.

WHY DOES THE REPRODUCIBILITY OF SYSTEMATIC REVIEWS MATTER?

One of the nine principles of scientific integrity in research per a Scientific Integrity Consortium is to encourage the reproducibility of research through transparency^[3]. Systematic reviews are regarded as the highest level of empirical evidence in clinical practice and policymaking. Therefore, they must adhere to the highest standards of scientific integrity to be considered credible and reliable. The steps outlined

below can help researchers to enhance the scientific integrity of systematic reviews.

STEP 1: FORMULATE A JUSTIFIED RESEARCH QUESTION

A justified research question is grounded on an existing research gap. Formulating a research question is the first step when conducting a systematic review. According to the PRISMA 2020 Statement, you can either state a research question or a review aim, but most importantly, it must be rationalized^[4]. You must state why you're conducting the review.

STEP 2: IDENTIFY SOURCES OF INFORMATION

The information used in systematic reviews is primary studies. You must identify the sources of primary studies. This is where the main barrier to conducting a reproducible systematic review lies. PRISMA 2020 recommends a comprehensive literature search, which involves searching multiple databases. Access to most of these databases requires institutional access or individual subscriptions. For example, Embase, one of the most commonly searched databases in healthcare sciences, requires a separate subscription of about \$2500 per month, which can be incredibly expensive for many researchers, especially those from limited resource

settings. Since most researchers want to be associated with such premium databases, some may be tempted to lie that they searched them when they only searched freely accessible sources like PubMed and Google Scholar. That is probably why most published systematic review search strategies are not reproducible. For a reproducible systematic review, it is better to report that you only searched the freely accessible sources rather than including databases you never searched because you may be interested in tricking the peer-review process and getting published in a high-impact journal. That can be highly detrimental to the scientific community, particularly those that rely on your findings to make decisions that directly affect people's lives. Nonetheless, if you are affiliated with an institution like a university, hospital, or even a government office, you can access some of the premium databases via your institution's subscription for free. If you come from a limited resource setting, you can utilize programs like Research4Life to access databases like Scopus and Embase for free^[5].

STEP 3: CONDUCT SEARCH: FORMULATE ELIGIBILITY CRITERIA AND SEARCH STRATEGIES

For a reproducible systematic review, the eligibility criteria need to be justifiable. For example, if you decided to include studies published in 2000 and onwards, you must justify why those were not published earlier. That makes others understand your decisions, making

replicating your review easier. Also, copying and pasting your exact input string to a given database is essential when formulating search strategies. Also, indicate the date when you searched the database. This will allow others to limit their search date to your search date and easily replicate your search strategy. Remember that although search terms may be the same across databases, the search strings for fields may differ. For example, if you search the title and abstract fields only to improve the recall rate on PubMed, you must provide this string before the search term [Title/Abstract] or [TiAb]. It is recommended that you read the "how to" guidelines for each database and customize the search strings to the specific conventions of that database. If you find it challenging, you can seek help from an experienced librarian from your affiliated institution.

STEP 4: SCREEN STUDIES USING SOFTWARE

Software like Rayyan^[6] and Covidence^[7] are widely recognized for study screening in the systematic review community. They can enhance systematic reviews' reproducibility by storing information on how each study was screened and the decisions made. Ensure that you indicate in your methods section the formats you used to export search results from databases to Rayyan or Covidence. Examples of formats include CSV, RIS, Endnote, etc. Please note that whereas Rayyan supports multiple formats, including CSV, Covidence only supports a

few. Therefore, when you export results from some databases like PubMed, you may still need to rely on online tools to convert the exported format into a format supported by Covidence. This is especially true when exporting the Nbib format from PubMed to Covidence. Since Covidence does not support CSV and Nbib, you need to use an online tool to convert Nbib to a format like RIS before exporting to Covidence. While screening studies, ensure that exclusion reasons are indicated for every excluded research, whether at the title/abstract or full-text screening stage. This is easier done using Rayyan, but for Covidence, you can only include exclusion reasons at the full-text screening stage. Therefore, it is recommended that you use labels at the title/abstract screening stage when using Covidence. When you are done, download the Excel file indicating exclusion reasons/labels from this software and store it safely. The journal you submit to may request it, or you can store it in the cloud so that you can share it with anyone who wants to reproduce your review. This significantly enhances transparency and hence upholds scientific integrity.

STEP 5: EXTRACT DATA FROM ELIGIBLE STUDIES

Extract data from eligible studies after the screening stage using a standardized data extraction form in an Excel spreadsheet. Do not dispose of the extracted data even after your systematic review is accepted for publication by a journal. Instead, keep it safe even on a cloud platform unless you submit it as supplementary material

to the journal, and readers can easily access it. In this way, you enhance the transparency in your data extraction process.

STEP 6: ANALYZE YOUR DATA

When analyzing your data, indicate the exact steps and specific decisions you made and why. For example, if your systematic review includes a meta-analysis, justify the models you used and why. If you do not, your meta-analysis may have limited reproducibility because different models can give slightly different figures in the output. Some models may indicate a particular outcome as statistically significant, while others may not. Therefore, always specify and justify your choice models. The same happens to narrative synthesis and other data analytic procedures undertaken.

STEP 7: WRITE YOUR SYSTEMATIC REVIEW

When reporting your systematic review, strictly follow an established guideline like PRISMA. Adhere to all the items to ensure transparent reporting and promote your systematic review's reproducibility.

SUMMARY

In conclusion, this article provides practical, step-by-step guidance for conducting a reproducible systematic review, emphasizing transparency, justification, and accurate reporting at every stage—from formulating the research question to data analysis and write-up. It is not intended to be a

comprehensive guide to systematic reviews in general but rather a focused resource for researchers who want to ensure others can replicate their review. For a broader understanding of

conducting a systematic review, readers are encouraged to supplement this with more comprehensive resources or formal training.

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